AMENDMENTS TO THE CLAIMS

Claim 1. (currently amended) An image processing device comprising:

display means having predetermined gradation characteristics;

image input means for inputting an image composed of a plurality of pixels;

contrast estimation means for estimating contrast of the image; and

luminance correction means for correcting luminance of each of the plurality of pixels constituting the image based on a function derived from estimated contrast and [[the]] said predetermined gradation characteristics of said display means,

wherein the luminance correction means corrects the luminance of each of the plurality of pixels by making the luminance data linearly symmetrical with [[the]] said predetermined gradation characteristics of said display means and

the display means displays the image in which the luminance of each of the pixels has been corrected by the luminance correction means.

Claim 2. (currently amended) An image processing device comprising:

display means having predetermined gradation characteristics;

image input means for inputting an image composed of a plurality of pixels;

character region extracting means for extracting a character region in which characters are drawn, from the image;

sharpening means for carrying out sharpening for remaining regions other than the character region in the image at a predetermined sharpening level and for carrying out sharpening for the character region at a sharpening level higher than the level of the sharpening performed for the remaining regions; and

luminance correction means for correcting luminance of each of the plurality of pixels constituting the character region and the remaining regions subjected to the sharpening based on [[the]] said predetermined gradation characteristics of [[the]] said display means,

wherein the luminance correction means corrects the luminance of each of the plurality of pixels by making the luminance data linearly symmetrical with [[the]] said predetermined gradation characteristics of [[the]] said display means and

the display means displays the image in which the luminance of each of the pixels has been corrected by the luminance correction means.

Claim 3. (previously presented) The image processing device of claim 2,

wherein the sharpening means independently obtains the luminance g(x, y) of each of the sharpened pixels by substituting the luminance f(x, y) of each of the plurality of pixels constituting the image and the coefficient h(x, y) of the sharpening level of each of the pixels into the following expression:

$$g(x, y) = f(x, y) - h(x, y) \times \nabla^2 f(x, y)$$

and

the coefficient h(x, y) of the sharpening level of each of the pixels is a predetermined first constant αi in the case where each of the pixels is in the remaining regions, and the coefficient is a second constant αc larger than the first constant αi in the case where each of the pixels is in the character regions.

Claim 4. (previously presented) The image processing device of claim 2,

wherein the character region extracting means converts the luminance of each of the plurality of pixels constituting the image into binary form, obtains one or more blocks of connected pixels composed of a plurality of pixels having mutually equal binary-coded luminance, obtains the circumscribed rectangles circumscribing the blocks of connected pixels, and integrates the circumscribed rectangles overlapping with one another at least at portions into a single circumscribed rectangle, and

from among regions of the circumscribed rectangles used as contours in the image, the character region extracting means extracts a region in which the difference between the maximum value and minimum value of luminance of the plurality of pixels in the respective regions is not less than a reference difference value, as a character region.

Claim 5. (previously presented) The image processing device of claim 2,

wherein the character region extracting means converts the luminance of each of the plurality of pixels constituting the image into binary form, obtains one or more blocks

of connected pixels composed of a plurality of pixels having mutually equal binary-coded luminance, obtains the circumscribed rectangles circumscribing the blocks of connected pixels, and integrates the circumscribed rectangles overlapping with one another at least at portions into a single circumscribed rectangle, and

from among regions in the image with the circumscribed rectangles used as contours, the character region extracting means extracts regions arranged in nearly parallel with a predetermined reference axis line as character regions.

Claim 6. (original) An image processing device of claim 2, further comprising:

contrast estimation means for estimating contrast of the image, and

contrast correction means for raising the contrast of the image on the basis of estimated contrast.

Claim 7. (canceled)

Claim 8. (previously presented) The image processing device of claim 2, wherein, in the case where the luminance of each of the plurality of pixels is represented by the sum of predetermined three color components, the character region extracting means extracts character regions on the basis of the sum of the three color components, the sharpening means individually sharpens the three color components, and the luminance correction means individually corrects the three color components.

Claim 9. (currently amended) An image processing method comprising the steps of:

inputting an image composed of a plurality of pixels;

estimating contrast of the image;

correcting luminance of each of the plurality of pixels constituting the image on the basis of a function derived from estimated contrast and gradation characteristics of display means for displaying the image; and

displaying the image, in which the luminance of each of the plurality of pixels has been corrected, on the display means,

wherein correcting luminance includes correcting the luminance of each of the plurality of pixels by making luminance data linearly symmetrical with the [[contrast and]] gradation characteristics of the display means.

Claim 10. (previously presented) An image processing method comprising the steps of:

inputting an image composed of a plurality of pixels;

extracting character regions with drawn characters in the image;

sharpening remaining regions other than the character regions in the image at a predetermined sharpening level and sharpening the character regions in the image at a sharpening level higher than the level of the sharpening performed for the remaining regions;

correcting the luminance of each of the plurality of pixels constituting the character regions and the remaining regions subjected to the sharpening on the basis of the gradation characteristics of display means for displaying the image; and

displaying the image, in which the luminance of each of the plurality of pixels has been corrected, on the display means

wherein correcting luminance includes correcting the luminance of each of the plurality of pixels by making the luminance data linearly symmetrical with the gradation characteristics of display means.

Claim 11. (previously presented) The image processing device of claim 1,

wherein the contrast estimate means estimates contrast (Lv, Hv) as contrast of the input image, which is defined by a combination of luminance Lv corresponding to a color of lines and dots generated in the input image and luminance Hv corresponding to a color of a background of the input image, and

the luminance correction means raises the contrast (Lv, Hv) of the input image to a maximum of contrast (Vmin, Vmax) which is defined by a combination of lower limit of luminance Vmin and upper limit of luminance Vmax of possible luminances, so that a lower luminance and higher luminance of luminances Lv, Hv which define the contrast

of the input image are converted to the lower limit of luminance Vmin and upper limit of luminance Vmax.

Claim 12. (previously presented) The image processing method of claim 9,

wherein the estimated contrast (Lv, Hv) is defined by a combination of luminance Lv corresponding to a color of lines and dots generated in the input image and luminance Hv corresponding to a color of a background of the input image, and

wherein the contrast (Lv, Hv) of the input image is raised to a maximum of contrast (Vmin, Vmax) which is defined by a combination of lower limit of luminance Vmin and upper limit of luminance Vmax of possible luminances, so that a lower luminance and higher luminance of luminances Lv, Hv which define the contrast of the input image are converted to the lower limit of luminance Vmin and upper limit of luminance Vmax.

Claim 13. (previously presented) An image processing device of claim 6,

wherein the contrast estimation means generates a histogram of luminance of pixels constituting the image, and

the histogram provides a first luminance value corresponding to a maximum value of frequency in the histogram in a first range which ranges from a predetermined reference luminance to a maximum of luminance which can be taken by the pixels,

the histogram provides a maximum value of frequency in the histogram in a second range of values which is not less than a minimum of luminance which can be taken by the pixels and less than the reference luminance, and

if the maximum value of the frequency in histogram in the second range is not less than a predetermined reference value, then the contrast estimation means estimates the contrast of the image on the basis of the first luminance value and the luminance value corresponding the maximum value of the frequency in the histogram in the second range, and

if the maximum value of the frequency in the histogram in the second range is less than the reference value, the contrast estimation means estimates the contrast of

the image on the basis of the first luminance value and the lowest luminance value among the luminance values of all the pixels constituting the image.

Claim 14. (currently amended) The image processing device of claim 1, wherein the luminance correction means corrects the luminance of each of the plurality of pixels by making the luminance data linearly symmetrical with the gradation characteristics so that the gradation characteristics of the display [[device]] means are linear.

Claim 15. (currently amended) The image processing device of claim 2, wherein the luminance correction means corrects the luminance of each of the plurality of pixels by making the luminance data linearly symmetrical with the gradation characteristics so that the gradation characteristics of the display [[device]] means are linear.

Claim 16. (currently amended) An image processing device comprising:

display means having predetermined gradation characteristics;

image input means for inputting an image composed of a plurality of pixels;

contrast estimation means for estimating contrast of the image; and

luminance correction means for correcting luminance of each of the plurality of pixels constituting the image based on a function derived from estimated contrast and [[the]] said predetermined gradation characteristics of said display means,

wherein the luminance correction means corrects the luminance of each of the plurality of pixels so as to reduce nonlinearity of [[with the]] said predetermined gradation characteristics of [[the]] said display means and

the display means displays the image in which the luminance of each of the pixels has been corrected by the luminance correction means.

Claim 17. (previously presented) The image processing device of claim 16,

wherein the contrast estimate means estimates contrast (Lv, Hv) as contrast of the input image, which is defined by a combination of luminance Lv corresponding to a color of lines and dots generated in the input image and luminance Hv corresponding to a color of a background of the input image, and

the luminance correction means raises the contrast (Lv, Hv) of the input image to a maximum of contrast (Vmin, Vmax) which is defined by a combination of lower limit of luminance Vmin and upper limit of luminance Vmax of possible luminances, so that a lower luminance and higher luminance of luminances Lv, Hv which define the contrast of the input image are converted to the lower limit of luminance Vmin and upper limit of luminance Vmax.

Claim 18. (currently amended) The image processing device of claim 16, wherein the luminance correction means corrects the luminance of each of the plurality of pixels with the gradation characteristics so that the gradation characteristics of the display [[device]] means are linear.

Claim 19. (currently amended) An image processing device comprising:

display means having predetermined gradation characteristics;

image input means for inputting an image composed of a plurality of pixels;

character region extracting means for extracting a character region in which characters are drawn, from the image;

sharpening means for carrying out sharpening for remaining regions other than the character region in the image at a predetermined sharpening level and for carrying out sharpening for the character region at a sharpening level higher than the level of the sharpening performed for the remaining regions; and

luminance correction means for correcting luminance of each of the plurality of pixels constituting the character region and the remaining regions subjected to the sharpening based on [[the]] said predetermined gradation characteristics of [[the]] said display means,

wherein the luminance correction means corrects the luminance of each of the plurality of pixels [[with the]] so as to reduce nonlinearity of said predetermined gradation characteristics of [[the]] said display means and

the display means displays the image in which the luminance of each of the pixels has been corrected by the luminance correction means.

Claim 20. (previously presented) The image processing device of claim 19,

wherein the sharpening means independently obtains the luminance g(x, y) of each of the sharpened pixels by substituting the luminance f(x, y) of each of the plurality of pixels constituting the image and the coefficient h(x, y) of the sharpening level of each of the pixels into the following expression:

$$g(x, y) = f(x, y) - h(x, y) \times \nabla^2 f(x, y)$$

and

the coefficient h(x, y) of the sharpening level of each of the pixels is a predetermined first constant αi in the case where each of the pixels is in the remaining regions, and the coefficient is a second constant αc larger than the first constant αi in the case where each of the pixels is in the character regions.

Claim 21. (previously presented) The image processing device of claim 19,

wherein the character region extracting means converts the luminance of each of the plurality of pixels constituting the image into binary form, obtains one or more blocks of connected pixels composed of a plurality of pixels having mutually equal binary-coded luminance, obtains the circumscribed rectangles circumscribing the blocks of connected pixels, and integrates the circumscribed rectangles overlapping with one another at least at portions into a single circumscribed rectangle, and

from among regions of the circumscribed rectangles used as contours in the image, the character region extracting means extracts a region in which the difference between the maximum value and minimum value of luminance of the plurality of pixels in the respective regions is not less than a reference difference value, as a character region.

Claim 22. (previously presented) The image processing device of claim 19,

wherein the character region extracting means converts the luminance of each of the plurality of pixels constituting the image into binary form, obtains one or more blocks of connected pixels composed of a plurality of pixels having mutually equal binary-coded luminance, obtains the circumscribed rectangles circumscribing the blocks of

connected pixels, and integrates the circumscribed rectangles overlapping with one another at least at portions into a single circumscribed rectangle, and

from among regions in the image with the circumscribed rectangles used as contours, the character region extracting means extracts regions arranged in nearly parallel with a predetermined reference axis line as character regions.

Claim 23. (previously presented) An image processing device of claim 19, further comprising:

contrast estimation means for estimating contrast of the image, and

contrast correction means for raising the contrast of the image on the basis of estimated contrast.

Claim 24. (previously presented) An image processing device of claim 19,

wherein the contrast estimation means generates a histogram of luminance of pixels constituting the image, and

the histogram provides a first luminance value corresponding to a maximum value of frequency in the histogram in a first range which ranges from a predetermined reference luminance to a maximum of luminance which can be taken by the pixels,

the histogram provides a maximum value of frequency in the histogram in a second range of values which is not less than a minimum of luminance which can be taken by the pixels and less than the reference luminance, and

if the maximum value of the frequency in histogram in the second range is not less than a predetermined reference value, then the contrast estimation means estimates the contrast of the image on the basis of the first luminance value and the luminance value corresponding the maximum value of the frequency in the histogram in the second range, and

if the maximum value of the frequency in the histogram in the second range is less than the reference value, the contrast estimation means estimates the contrast of the image on the basis of the first luminance value and the lowest luminance value among the luminance values of all the pixels constituting the image.

Claim 25. (previously presented) The image processing device of claim 19, wherein, in the case where the luminance of each of the plurality of pixels is represented by the sum of predetermined three color components, the character region extracting means extracts character regions on the basis of the sum of the three color components, the sharpening means individually sharpens the three color components, and the luminance correction means individually corrects the three color components.

Claim 26. (currently amended) The image processing device of claim 19, wherein the luminance correction means corrects the luminance of each of the plurality of pixels by making the luminance data linearly symmetrical with the gradation characteristics so that the gradation characteristics of [[the]] said display [[device]] means are linear.

Claim 27. (currently amended) An image processing method comprising the steps of:

inputting an image composed of a plurality of pixels;

estimating contrast of the image;

correcting luminance of each of the plurality of pixels constituting the image on the basis of a function derived from estimated contrast and gradation characteristics of display means for displaying the image; and

displaying the image, in which the luminance of each of the plurality of pixels has been corrected, on the display means,

wherein correcting luminance includes correcting the luminance of each of the plurality of pixels [[with the contrast and]] so as to reduce nonlinearity of the gradation characteristics of the display means.

Claim 28. (previously presented) The image processing method of claim 27,

wherein the estimated contrast (Lv, Hv) is defined by a combination of luminance Lv corresponding to a color of lines and dots generated in the input image and luminance Hv corresponding to a color of a background of the input image, and

wherein the contrast (Lv, Hv) of the input image is raised to a maximum of contrast (Vmin, Vmax) which is defined by a combination of lower limit of luminance Vmin and upper limit of luminance Vmax of possible luminances, so that a lower

luminance and higher luminance of luminances Lv, Hv which define the contrast of the input image are converted to the lower limit of luminance Vmin and upper limit of luminance Vmax.

Claim 29. (currently amended) An image processing method comprising the steps of:

inputting an image composed of a plurality of pixels;

extracting character regions with drawn characters in the image;

sharpening remaining regions other than the character regions in the image at a predetermined sharpening level and sharpening the character regions in the image at a sharpening level higher than the level of the sharpening performed for the remaining regions;

correcting the luminance of each of the plurality of pixels constituting the character regions and the remaining regions subjected to the sharpening on the basis of a function derived from the gradation characteristics of display means for displaying the image; and

displaying the image, in which the luminance of each of the plurality of pixels has been corrected, on the display means

wherein correcting luminance includes correcting the luminance of each of the plurality of pixels [[with]] so as to reduce nonlinearity of the gradation characteristics of display means.